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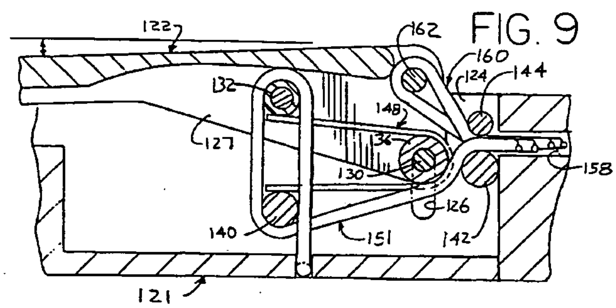
(54) **Cable-actuated jaw assembly for surgical instruments**

(57) A jaw assembly is provided with a pair of jaws which are closed with a flexible, tension member that is pulled by the operator of the instrument. In a preferred embodiment, one of the jaws is pivotally mounted in a slot to the other jaw. A cord, having a loop configuration, is attached to the pivoting jaw and can be pulled to pivot the jaw closed. A second cord can be provided to initially hold the proximal end of the pivoting jaw away from the other jaw until the distal ends of the jaws are closer together. In another embodiment, jaws can be closed in a parallel orientation by rotating two pulleys with threaded shafts engaged with the jaws.

FIG. 9



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Description

This invention relates generally to surgical instruments and is especially suitable for incorporation in various instruments used in endoscopic procedures as well as in open surgery procedures.

A variety of designs have been commercialized or proposed for instruments incorporating a pair of cooperating jaws (i.e., a jaw assembly) in which one jaw pivots or otherwise moves relative to the other jaw between open and closed positions. Examples of such instruments include tissue graspers, tissue clamps, needle graspers, tissue cutters, linear staplers, ligating clip appliers, and the like.

In many surgical procedures, the working area is confined, and instruments with relatively small cross sections are necessary or preferred.

Some instrument designs have been developed for linear stapler systems wherein one jaw functions as an anvil and the other jaw carries a row or rows of staples. The anvil jaw can be closed manually to trap layers of tissue between the two jaws. Then, a suitable mechanism is actuated to discharge the staples through the tissue and against the anvil jaw.

In US-A-3739784 there is disclosed a pair of forceps for use with an endoscope. The forceps comprise a leg and an arm member swingably mounted on a pin provided on the leg. A free end of the arm is connected to a wire so that the arm is swung outwardly when the wire is pushed forwardly by a user and the arm is swung inwardly when the wire is pulled rearwardly.

As used herein, the term "endoscopic" pertains generally to the use of a surgical instrument which is inserted into a body cavity in conjunction with an endoscope that is inserted into the same body cavity. The endoscope permits visual inspection, with or without magnification, of the interior of the body cavity and permits observation of the operation of the surgical instrument for therapeutic or diagnostic purposes.

In a typical endoscopic surgical procedure, the abdominal cavity of a human or animal subject is insufflated with a sterile gas, such as carbon dioxide, in order to provide increased maneuvering room within the body cavity for endoscopic instruments. Then, conventional trocars are inserted into the subject's body cavity through the surrounding skin, tissue, and musculature. A conventional trocar typically consists of a trocar cannula which houses an elongated trocar obturator. Trocar obturators typically have a piercing point, although other types of obturators are also available.

After each trocar has been positioned within the body cavity adjacent the target surgical site, the trocar obturator is removed leaving the trocar cannula as a pathway to the body cavity. A plurality of trocar cannulas are typically placed in this manner. The surgeon can then insert an endoscope through one of the trocar cannulas and can insert various types of endoscopic, surgical instruments through one or more of the other trocar cannulas at the target surgical site where the diagnostic or therapeutic surgical procedure is performed.

The endoscope is typically connected to a video camera, and the output from the video camera is fed to a video monitor which displays the surgical site and the end of the endoscopic instrument at the surgical site. Some endoscopic instruments incorporate a pair of jaws (e.g., ligating clip appliers, tissue cutters, tissue graspers, needle graspers, and the like).

When pivotally-mounted jaws are employed to clamp or squeeze tissue, the proximal portions of the jaws typically engage the tissue before the distal portions of the jaws engage the tissue. This can cause the tissue to be forced distally in the jaws, and the tissue may then not be properly engaged by the jaws. It would be desirable to provide an improved jaw assembly that could close the jaws in a way that would eliminate or minimize the tendency of the tissue to move along the jaws as the jaws close.

In accordance with the present invention, there is provided a jaw assembly for a surgical instrument as claimed in Claim 1 hereinafter.

According to the principles of the present invention, a unique jaw assembly is provided for a surgical instrument. The jaw assembly can be readily incorporated in an articulating instrument where the jaw assembly can be articulated relative to the rest of the instrument and can still be operated to open and close the jaws. The jaw assembly is relatively strong and can be operated to apply relatively high jaw closing forces.

The jaw assembly is readily operated from the proximal end of the instrument without requiring the application of excessively high input forces or torques.

Embodiments of the jaw assembly can be designed to provide a significant amount of internal clearance to accommodate components extending from the proximal end of the instrument through the jaw assembly. The internal region of the jaw assembly can also be designed to accommodate the passage of fasteners, such as ligating clips or staples.

The jaw assembly design can also be incorporated in embodiments wherein the tissue is compressed between substantially parallel jaws or between the distal ends of pivoting jaws so as to eliminate or minimize the movement of the tissue relative to the jaws when the jaws close.

The jaw assembly can be provided with a relatively smooth exterior configuration to minimize potential contamination sites or tissue snagging sites.

The jaw assembly includes a pair of jaws which are closed with a flexible, tension member that is pulled by the operator of the instrument. Such a flexible tension member may be a unitary or composite cord, cable, thin strip of metal or plastic, string, filament, or the like having a single strand or element as well as multiple strands or elements. Such a flexible, tension member transmits applied tension force but is typically ineffective to transmit any substantial compressive force. For convenience, the term "cord" is used throughout this specification and in the claims to broadly denote such a

flexible, tension member.

A pair of jaws is provided in which one jaw is movable relative to the other. The jaws are actuated with an operating cord. The cord defines a loop having one portion operatively engaged with the movable jaw and another portion adapted to be engaged so as to apply tension to at least part of the loop to effect movement of the movable jaw. The use of an endless loop construction is especially advantageous with some types of cord materials wherein it is difficult to securely attach a cord end to instrument components because of cord brittleness or lubricity (e.g., liquid crystal materials or thermoplastic, polymer materials having a relatively low coefficient sliding friction).

The assembly includes a first jaw having a distal end and a proximal end and includes a movable second jaw having a distal end and a proximal end. The second jaw is mounted for pivoting movement about a pivot axis toward and away from the first jaw.

One of the jaws defines an elongate slot adjacent its proximal end. The other jaw has a transversely extending shaft adjacent its proximal end and received in the slot for mounting the jaws together to accommodate translation and pivoting movement of the second jaw toward and away from the first jaw.

A first operating cord is engaged with the second jaw at a first location distally of the shaft for pulling the second jaw to pivot the second jaw distal end toward the first jaw. Means, for example a spring or a second operating cord, are provided for urging the second jaw to pivot away from the first jaw.

The assembly also comprises means for urging the second jaw proximal end away from the first jaw only during an initial portion of the pivoting movement of the second jaw distal end toward said first jaw. This permits the tissue to be initially engaged between the distal ends of the jaws so as to minimize the tendency of the tissue to be moved distally along the jaws during the closure of the jaws. In one embodiment, the first operating cord is also engaged with the second jaw at a second location proximally of the first location. In another embodiment, the second jaw proximal end is urged away from the first jaw by means of a spring.

In some applications it is desirable to provide a second operating cord. The second operating cord is engaged with the second jaw and is arranged to pull the second jaw proximal end away from the first jaw when the second operating cord is tensioned. If the second operating cord is tensioned when the first operating cord is initially pulled, then the proximal end of the second jaw is initially held away from the first jaw so that the distal end of the second jaw moves toward the first jaw and engages the material between the jaws before the proximal end of the second jaw engages the material. This minimizes the tendency of the tissue to be moved distally along the jaws during the closure of the jaws.

In one embodiment, the jaw assembly also includes a lever which has a lever pivot axis and which is mounted for pivoting movement about the lever pivot axis. The lever defines first and second surfaces for engaging the first operating cord. The distance between the lever pivot axis and any part of the first surface is less than the distance between the lever pivot axis and any part of the second surface. When the first cord is pulled, the lever pivots to change the length of the lever arm through which the first cord acts. This assembly can be arranged so that the second jaw is first pulled by the first cord with lower force through a longer range of movement and is subsequently pulled with higher force through a shorter range of movement.

In another embodiment the first jaw has a lateral guide surface. An operating cord defining a U-shaped loop configuration is engaged with the second jaw. The cord has at least one trailing portion extending around the lateral guide surface whereby the trailing portion can be pulled to urge at least one of the jaws toward the other of the jaws.

Another form of the jaw assembly includes a first jaw and a first guide surface fixed relative to the first jaw. A movable second jaw having a second guide surface is mounted for pivoting movement toward and away from the first jaw. A spring biases the second jaw relative to the first jaw for urging the second jaw to pivot away from the first jaw. A cord is provided with a portion fixed relative to the first jaw. The cord has a trailing portion trained sequentially from the fixed portion around the second guide surface and then around the first guide surface for pulling the second jaw to pivot toward the first jaw.

Numerous other advantages and features of the present invention will become readily apparent from the following detailed description of the invention, from the claims, and from the accompanying drawings.

In the accompanying drawings that form part of the specification, and in which like numerals are employed to designate like parts throughout the same,

FIG. 1 is a simplified, exploded, perspective view of the distal end of portion of an instrument which includes a first embodiment of the jaw assembly of the present invention;

FIG. 2 is a simplified, schematic representation of the proximal portion of the instrument showing the handle and a lever for operating the jaws;

FIG. 3 is a fragmentary, top plan view of the jaw assembly illustrated in FIG. 1, but FIG. 3 shows the jaw assembly in an open position with portions of the upper or second jaw cut away to illustrate interior detail;

FIG. 4 is a fragmentary, cross-sectional view taken generally along the plane 4-4 in FIG. 3;

FIG. 5 is a view similar to FIG. 4, but FIG. 4 shows a partially closed condition of the jaw assembly;

FIG. 6 is a view similar to FIG. 5 but shows a completely closed condition of the jaw assembly;

FIG. 7 is a fragmentary view similar to FIG. 3 and shows the jaw assembly in an articulated position at an oblique angle relative to the instrument longitudi-

nal axis;

FIG. 8 is a fragmentary, cross-sectional view of a second embodiment of a jaw assembly in an open position;

FIG. 8A is a cross-sectional view taken generally along plane 8A-8A in FIG. 8;

FIG. 8B is a fragmentary, cross-sectional view taken generally along the planes 8B-8B in FIG. 8;

FIG. 9 is a view similar to FIG. 8, but FIG. 9 shows the jaw assembly in a partially closed condition;

FIG. 10 is a view similar to FIG. 9, but FIG. 10 shows the jaw assembly in a fully closed condition;

FIG. 11 is a fragmentary, cross-sectional view of a third embodiment of a jaw assembly;

FIG. 12 is a view similar to FIG. 11, but FIG. 12 shows the jaw assembly in a closed condition;

FIG. 13 is a fragmentary, cross-section view of a fourth embodiment of a jaw assembly;

FIG. 13A is a fragmentary view similar to FIG. 13 but FIG. 13A shows the side of the jaw assembly opposite from that visible in FIG. 13;

FIG. 14 is a fragmentary, bottom view of the jaw assembly taken generally along the plane 14-14 in FIG. 13.

FIG. 15 is a fragmentary, perspective view of a fifth embodiment of the jaw assembly;

FIG. 16 is a view similar to FIG. 15, but FIG. 16 shows the jaw assembly partially closed;

FIG. 17 is a view similar to FIG. 16, but FIG. 17 shows the jaw assembly in the fully closed condition; and

FIG. 18 is a cross-sectional view taken generally along the plane 18-18 in FIG. 15.

One aspect of the present invention relates to a jaw assembly which can be incorporated in a variety of designs providing unique operational characteristics and capabilities. In particular, the jaw assembly is readily adapted for use at the distal end of an instrument which can be articulated. The jaw assembly is operable during and after articulation.

Further, some embodiments of the jaw assembly provide a mechanical advantage for increasing jaw force.

Closure of the jaws is effected by moving the distal end of one of the jaws to a closed location before the proximal portion of the jaw is fully moved to a closed location. This minimizes the movement of tissue along the jaws during the jaw closing process.

The jaw assembly is relatively strong and can be provided with an exterior configuration that minimizes structural projections that might snag on tissue or accumulate contaminants.

In addition, the jaw assembly can be employed in instruments with devices for effecting a variety of functions with respect to the surgical site. Such functions can include, but are not limited to, grasping, clamping, applying staples or ligating clips, applying ultrasonic energy, irrigating the surgical site, or removing material from the site by aspiration or suction.

Various embodiments can be provided with sufficient interior space to accommodate internal passages and components (e.g., sensor lines, conduits, fastener actuation systems, etc.). Components for various sensor systems can be routed through the novel jaw assembly. Such sensor systems can include, but are not limited to, systems for measuring tissue thickness or compression, tumor sensing, pulse oximetry, and doppler effect sensing of fluid in vessels. Also, light guides and other fiber optic system components may be routed through the assembly.

Further, the jaw assembly of the present invention accommodates various designs for venting or sealing the instrument in which the jaw assembly is incorporated, and the jaw assembly design accommodates the use of filters for filtering gas and smoke.

While this invention is susceptible of embodiment in many different forms, this specification and the accompanying drawings disclose only some specific forms as examples of the invention. The invention is not intended to be limited to the embodiments so described, however. The scope of the invention is pointed out in the appended claims.

For ease of description, the jaw assembly embodiments of this invention are described in various operating positions, and terms such as upper, lower, horizontal, etc., are used with reference to these positions. It will be understood, however, that jaw assemblies incorporating this invention may be manufactured, stored, transported, used, and sold in an orientation other than the position described.

Figures illustrating the jaw assemblies show some mechanical elements that are known and that will be recognized by one skilled in the art. The detailed descriptions of such elements are not necessary to an understanding of the invention, and accordingly, are herein presented only to the degree necessary to facilitate an understanding of the novel features of the present invention.

The jaw assemblies incorporating the present invention can be used in instruments that have certain conventional components the details of which, although not fully illustrated or described, will be apparent to those having skill in the art and an understanding of the necessary functions of such components.

FIGS. 1-7 schematically illustrate some basic features of a first embodiment of the jaw assembly of the present invention. The jaw assembly is adapted to be mounted to a proximal portion of an open surgery or endoscopic instrument, and the proximal portion may typically be a support housing 34 (FIG. 2). This part of the instrument is grasped by the surgeon. In an endoscopic instrument, the proximal part of the housing 34 remains outside of the patient while the rest of the instrument is inserted through the trocar cannula (not illustrated) and into the body cavity.

The jaw assembly can be pivotally mounted to the instrument, and to this end the instrument includes a

mounting assembly 40 (FIG. 1) comprising a bottom bracket 42, a top bracket 44, and a support member 46. The lower bracket defines a bore 48, the upper bracket 44 defines a bore 50, and the support member 46 defines a bore 52. The components are assembled so that the bores 48, 52, and 50 are aligned to receive a hinge pin or pivot pin 54 (FIGS. 1 and 4). The proximal portions of the lower bracket 42 and upper bracket 44 are adapted to be mounted in a shaft tube 47 extending from the housing 34 by suitable means (not illustrated).

The support member 46 defines a cantilevered tongue 56 on which the jaw assembly is mounted. To this end, the jaw assembly includes a first or lower jaw 61 having a proximal portion in the form of a channel defined by a first side wall 64 (FIG. 1), a second side wall 66 (FIG. 1), and a bottom wall or floor 68 (FIG. 4). The projecting tongue 56 of the support member 46 is received within the proximal portion of the first jaw 61 as shown in FIG. 4 and is retained therein by suitable means (e.g., threaded fasteners, press fit, adhesive, welding or brazing, and the like (not illustrated)). The particular means by which the jaw assembly is attached to the tongue 56 or to any other portion of an instrument as may be desired, forms no part of the present invention.

The first jaw side wall 64 defines an aperture 69, and the first jaw side wall 66 defines an aperture 70. An oval lever arm 74 is disposed on a pin 72 which is mounted in the apertures 69 and 70 in the first jaw 61.

The jaw assembly includes an upper or second jaw 76 which has a proximal end portion defining a pair of bosses or ears 78. Each boss 78 defines a bore 80. The proximal portion of the second jaw 76 is received between the first jaw side walls 64 and 66. Each side wall 64 and 66 defines a vertically oriented, elongate slot 84. A shaft 86 is mounted through the slots 84 and through the second jaw bores 80 so as to retain the second jaw 76 mounted on the first jaw 61.

The length of each slot 84 is greater than the diameter of the shaft 86. The shaft 86 is thus free to translate vertically within the slots 84. This accommodates movement of the proximal portion of the second jaw 76 toward and away from the first jaw 61. Further, the shaft 86 may be characterized as defining a pivot axis about which the second jaw 76 can pivot. This pivot axis is, of course, not fixed and can translate relative to the first jaw 61 as the shaft 86 moves along the slots 84.

In the preferred embodiment illustrated, a spring 90 is mounted within the jaw assembly as illustrated in FIGS. 1 and 4. The spring 90 has a generally U-shaped configuration with the legs of the U bent over to define cradle portions 92 which engage the shaft 84 so as to bias the shaft, and hence the proximal end of the second jaw 76, upwardly away from the first jaw 61.

A cord 96 is provided for operating the jaw assembly to close the jaws. As discussed in greater detail under the section entitled "SUMMARY OF THE INVENTION," the term "cord" is used herein to refer generally to a flexible, tension member such as a cable, string, filament, thin strip of metal or plastic, or the like. The cord 96 may be a unitary or composite structure having a single strand or element. The cord 96 may also incorporate multiple strands or elements. Such structures and compositions may also be employed in cords used in the other jaw assembly embodiments described in detail hereinafter.

In the presently contemplated preferred embodiment, the cord 96 is a single loop of liquid crystal, polymer material having a relatively low coefficient of sliding friction. By using a continuous loop of the material, it is not necessary to attach or terminate a single end of the cord 96 to a component in the instrument. This is advantageous in the case of some types of cord materials wherein it is difficult to securely attach a cord end to instrument components. Such a loop structure may also be employed with cords used in other jaw assembly embodiments described in detail hereinafter.

The cord 96 defines a generally U-shaped configuration around the second jaw 76 and extends from the second jaw 76 around the lever 74. The cord 96 extends from the lever 74 beyond the proximal end of the jaw assembly where it may be pulled by a suitable means. In the embodiment illustrated in FIGS. 1-7, the instrument support member 46 defines an aperture 98 through which the cord 96 can extend proximally from the jaws 61 and 76. The cord 96 preferably extends to a proximal portion of the instrument, such as to the proximal end of the housing 34 (FIG. 2) where it can be pulled by the surgeon.

A presently preferred system for pulling the cord 96 is illustrated in FIG. 2 and comprises an L-shaped lever 100 pivotally mounted with a pin 102 to the housing 34. The loop of cord 96 extends through an aperture 104 in the operating lever 100. Because the spring 90 normally biases the second jaw 76 to the open position, the cord 96 is normally pulled distally so as to pull the operating lever 100 to a forward position against some suitable stop (not illustrated) in the housing 34. The surgeon can hold the proximal end of the housing 34 and squeeze the lever 100 rearwardly to pull the loop cord 96 proximally.

The distal end of the loop defined by the cord 96 is engaged with the second jaw 76. To this end, the outer surface of the second jaw 76 defines an arcuate groove 108 (FIG. 4)in which the cord 96 is seated. The cord 96 extends down both sides of the second jaw 76 into the channel section of the first jaw 61. The cord 96 is trained around, and engaged with, the exterior surface of the oval lever 74.

The lever 74 need not necessarily be oval but should have a first surface 111 and a second surface 112 (FIG. 4) wherein the distance between the lever pivot axis and any part of the first surface 111 is less than the distance between lever pivot axis and any part of the second surface 112. Preferably, the lever 74 is initially installed and engaged with the cord 96 such that the lever 74 has the orientation shown in FIG. 4 when the second jaw 76 is fully open. In particular, in this con-

dition, the longest portion of the lever 74 (e.g., the major axis of an oval-shaped lever) is oriented generally parallel to the lower jaw 61 and is generally parallel to the length of the instrument along which the proximal portion of the loop of cord 96 is pulled. The cord 96 extending between the lever 74 and the second jaw 76 defines an angle of almost 90° with respect to the length of cord 96 extending proximally from the lever 74.

When the cord 96 is pulled proximally, the length of cord along the first surface 111 applies tension through a relatively short lever arm while the portion of the cord along the second surface 112 applies tension through a relatively long lever arm. As the cord 96 is pulled proximally, the lever 74 pivots (counterclockwise as viewed in FIG. 4). As the lever pivots to the intermediate position illustrated in FIG. 5, the length of cord 96 between the lever 74 and second jaw 76 is subjected to a relatively long travel at a relatively lower force. As the cord 96 continues to be pulled proximally from the orientation illustrated in FIG. 5 to the orientation illustrated in FIG. 6, the portion of the cord 96 engaged with the first surface 112 applies tension through a relatively long lever arm while the portion of the cord extending from the lever arm 74 to the second jaw 76 is tensioned through a relatively short lever arm. Thus, the travel of the cord 96 adjacent the second surface 112 is translated into a shorter travel and is subjected to a higher force.

The effect of the operation of the jaw assembly is to initially move the second jaw 76 through a relatively large percentage of the distance toward the closed position at relatively low force and to subsequently pivot the second jaw 76 through a short, remaining arc to the fully closed position at a relatively high force. For example, if the lever 74 is elliptical, and if the length of the major axis is equal to twice the length of the minor axis, then the second jaw 76 will be initially pulled toward the fully closed position with a force equal to 1/2 of the input pulling force and will pivot through an arc (as measured at the radius where the cord 96 engages the top of the second jaw 76) having a length equal to twice the initial pulling stroke length. Subsequently, when the lever 76 has pivoted about 90° (to the position illustrated in FIG. 5), the second jaw 76 will apply a clamping force equal to twice the pulling force as the second jaw 76 moves through an arc length equal to 1/2 of the final pull stroke length.

With reference to FIG. 4 and 5, it will be appreciated that during an initial pivoting movement of the second jaw 76, the proximal end of the second jaw 76 remains substantially elevated because the spring 90 is biasing the shaft 86 upwardly in the slots 84. Thus, as illustrated in FIG. 5, the distal end of the second jaw 76 initially engages material (e.g., two layers of tissue T1 and T2) before the more proximal portions of the jaw 76 can engage the material. This tends to initially clamp the material between the distal ends of the two jaws and eliminate or minimize the normal tendency of material to move along conventional jaws which pivot closed about a fixed pivot axis.

After the distal portion of the second jaw 76 has been pivoted to the substantially closed position, further force exerted by the pulling cord 96 is sufficient to overcome the force of the spring 90, and the proximal end of the second jaw 76 is pulled toward the first jaw 61 until the jaw assembly is completely closed as illustrated in FIG. 6.

The jaw assembly illustrated in FIGS. 1-7 can be used in an articulating surgical instrument. Because the jaw assembly is mounted, via the first jaw 61, to the tongue 56 of the pivotal support member 46, the jaw assembly moves with the support member 46 as it pivots about the axis defined by the pin 54. An articulated orientation of the jaw assembly on the support member 46 is illustrated in FIG. 7. The support member 46 can be pivoted relative to the brackets 42 and 44 in which it is mounted by any suitable means. For example, a pulley (not illustrated) can be fixed to the support member 46, and a drive belt or cord can be trained around the pulley. The drive belt or cord can be driven from the proximal end of the instrument by suitable means, such as a manually operated knob, motor, or other appropriate device. The particular mechanism or system for effecting pivoting of the support member 46 forms no part of the present invention.

The first jaw 61 and second jaw 76 are shown as having generally solid distal end portions. It will be appreciated that one or both of the jaws may have other configurations and may include hollow portions. Indeed, one or both of the jaws may include auxiliary components for acting on the tissue that is adjacent or clamped between the jaws. For example, one or both of the jaws could incorporate sensor lines, aspiration conduits, irrigation conduits, and the like.

Further, the jaws may be adapted to apply tissue fasteners, such as clips or staples. For example, the first jaw 61 may be provided with a staple cartridge having a row or rows of staples, and the second jaw 76 may incorporate an anvil design so that both jaws can function as a linear stapler. A suitable mechanism can be provided in the staple-carrying jaw to discharge the staples through the tissue against the anvil jaw. Such a mechanism could be operated by means of an actuating member extending from the proximal end of the instrument into the staple-carrying jaw. Linear stapler designs which may be suitable for adaptation and incorporation into the jaw assembly of the present invention are illustrated in the U.S. Patent No. 4,610,383.

In the jaw assembly first embodiment described above, as well as in the other embodiments described hereinafter, the particular design of the portion of each jaw that engages the tissue and/or that contains auxiliary components of the type described above forms no part of the present invention. Further, it will be appreciated that the entire jaw assembly can be mounted in a fixed, as well as pivotable, arrangement to the distal end of an instrument (not shown). In this embodiment, as well as in other embodiments described hereinafter, the particular design of the structure for mounting the jaw

assembly to the instrument forms no part of the present invention.

Another embodiment of the jaw assembly of the present invention is illustrated in FIGS. 8, 8A, 8B, 9, and 10. The jaw assembly has a first jaw 121 and a second jaw 122. Each jaw has a distal end and a proximal end. The jaws 121 and 122 are mounted together at their proximal ends.

The first jaw 121 has a pair of spaced-apart walls 124 (FIGS. 8A and 8B), and each wall defines a fixed, elongated slot 126 (FIG. 9). The second jaw 122 defines a downwardly depending central wall 127 in which is mounted a shaft 130 (FIG. 9). The opposite ends of the shaft 130 are received in one of the a slots 126 defined in each adjacent side wall 124 of the first jaw 121. The shaft 130 defines a pivot axis about which the second jaw 122 pivots relative to the first jaw 121. The shaft 130 can translate along the length of each slot 126 so that the proximal end of the second jaw 122 can move toward and away from the first jaw 121.

The central wall 127 of the second jaw 122 includes a first pin or roller 132 at a first location distally of said shaft 130, and the pin or roller 132 has two end portions projecting in opposite directions from the second jaw central wall 127 (FIG. 8A). Further, on each side of the second jaw central wall 127 there is a roller 136 mounted on the shaft 130.

The first jaw 121 defines a guide portion in the form of a fixed first pin 140 which extends between the first jaw walls 124. A second pin 142 (FIGS. 8-10) is mounted proximally of the slot 126 between the first jaw walls 124. Spaced above the second pin 142 is a third pin 144 which is also mounted between the walls 124 of the first jaw 121.

A pair of V-shaped springs 148 are provided in the jaw assembly to normally bias the second jaw 122 to an open position (as shown in FIG. 8). One spring 148 is mounted on one side of the second jaw central wall 127, and the other spring 148 is mounted on the other side of the central wall 127. Each spring 148 is mounted so that the interior angle at the apex of the V-shaped configuration of the spring receives the roller 136 on the shaft 130. The upper leg of each spring 148 is biased outwardly against the second jaw first roller or pin 132, and the end of the other leg of each spring is biased outwardly against the first jaw first pin 140. This arrangement tends to continuously bias the second jaw 122 toward the open position.

The jaw assembly includes a first operating cord 151 which can be pulled from the proximal end of the instrument to pivot the second jaw 122 from the open position (FIG. 8) to the closed position (FIG. 10). In particular, the cord 151 has a generally U-shaped configuration around the first jaw 121 as illustrated in FIG. 8A. The first jaw 121 has a bottom wall 153 (FIG. 8A) which defines a transverse groove 154 and which defines two spaced-apart apertures 155 establishing communication between each end of the groove 154 and the interior of the first jaw 121.

The first cord 151 is seated within the groove 154, and portions of the cord 151 extend up through each aperture 155 on each side of the second jaw central wall 127. The cord is trained sequentially around the second jaw first roller 132, around the first jaw first pin 140, around the second jaw second roller 136, and finally around the first jaw second roller 142. The first cord 151 extends along both sides of the jaw assembly through an aperture 158 in the proximal portion of the first jaw 121. The two proximally extending lengths of the first cord 151 may then be routed to the proximal portion of the instrument to a location at which tension may be applied. The proximally extending lengths of the cord 151 can be joined together to form a continuous loop (FIG. 8B) and may be attached in the proximal portion of the instrument to an operating lever (e.g., similar to the lever 100 of the first embodiment of the jaw assembly described above with reference to FIG. 2). Alternatively, each proximally extending length of the cord 151 may be separately terminated at the proximal portion of the instrument to a lever or other device for pulling the cords proximally. The cord may even be manually grasped and pulled.

A second operating cord 160 is provided to pull on the proximal end of the second jaw 122. To this end, the proximal end of the second jaw 122 has a transversely projecting pin 162, and the second operating cord 160 is formed into a loop around the pin 162. The two lengths of the cord 160 extend proximally from the pin 162 between the first jaw pins 144 and 142 and through the first jaw aperture 158.

The proximally extending lengths of the second operating cord 160 extend to the proximal portion of the instrument along with the lengths of the first operating cord 151. As with the first operating cord 151, the second operating cord 160 is intended to be pulled or tensioned at the proximal end of the instrument by suitable means (not illustrated). The second operating cord 160 may be directly grasped and pulled or the second operating cord 160 may be engaged with a device operable by the surgeon for pulling the cord 160. The particular means for pulling the cord 160 form no part of the present invention.

The lengths of the second operating cord at the proximal end of the instrument may be joined together, as shown in FIG. 8B, so as to form a continuous loop. This permits engagement with a surgeon's finger, or with other mechanisms for pulling the loop, without the necessity of terminating separate cord end portions.

The first operating cord 151 and the second operating cord 160 may be provided in any of the compositions and constructions that have been described above for the cord 96 in the first embodiment of the jaw assembly illustrated in FIGS. 1-7.

The jaw assembly illustrated in FIGS. 8, 8A, 8B, 9, and 10 may be operated to provide a loading bias relative to the distal end of the jaws which is proportional to the total closure force applied and to the amount of closure. The jaw assembly initially loads the distal end of

the second jaw 122 with a fraction of the total closure force generated. Subsequently, the fraction of the total closure force increases as the second jaw 122 closes further and as the tissue reaction forces increase.

The initially open condition of the jaw assembly is established by pulling the second operating cord 160 to pivot the second jaw 122 upwardly relative to the first jaw 121. In this condition, the shaft 130 is urged against the bottom of the first jaw slots 126. The springs 148, acting between the first jaw pin 140 and the second jaw pin or roller 132, also force the jaws apart and insure that the first operating cable 151 is extended.

In order to initiate the closing of the jaws, the tension on the second operating cable 160 is released or partially released. The jaw opening springs 148 then move the proximal end of the first jaw 121 and the proximal end of the second jaw 122 further apart. This results in the second jaw shaft 130 moving upwardly to the upper end of the second jaw slots 126. The tension in the first operating cable 151 exerts an upward force on the shaft 130. As the tension in the first operating cable 151 is increased, the second jaw 122 pivots about the shaft 130 to lower the distal end of the second jaw 122 toward the first jaw 121 (FIG. 9).

Typically, tissue has been located between the jaws, and the distal end of the second jaw 122 engages the tissue and applies an increasing load or force on the tissue. As the tissue is compressed, the total reaction forces on the distal end of the second jaw 122 increase, and the first operating cord 151 must be pulled with increasingly greater force.

During a final closure portion of the jaw closing movement, the angle of the second jaw 122 relative to the first jaw 121 changes, and an increasing fraction of the total cable tension is transferred to the distal end of the second jaw 122. This permits the shaft 130 at the proximal end of the second jaw 122 to move downwardly in the slots 126 to provide a more uniform, final tissue compression. Because the tissue is initially compressed between the distal ends of the jaws and subsequently along an increasing length portion of each jaw, the tissue is not initially forced distally in the jaws. Thus, the tendency of the tissue to slip out of the jaws, as would be the case in a conventional pair of fixed pivot axis jaws, is eliminated or substantially minimized.

Another embodiment of the jaw assembly present invention is illustrated in FIGS. 11 and 12. The jaw assembly includes a first jaw 231 having a distal end and proximal end, and the assembly includes a second jaw 232 having a distal end and a proximal end. The proximal end of the first jaw 231 defines a pair of side walls 234 (only the far side wall 234 being visible in FIGS. 11 and 12). The proximal end of the second jaw 232 is received between the first jaw side walls 234. The proximal end of the second jaw 232 also defines a pair of side walls 236 (only the far side wall 236 being visible in FIGS. 11 and 12).

The side walls 236 of the second jaw 232 each define an elongate slot 238 adjacent the proximal end. The first jaw 231 has a transversely extending shaft or pin 240 adjacent its proximal end and received in the elongate slots 238 for mounting the jaws together to accommodate translation and pivoting movement of the second jaw 232 toward and away from the first jaw 231.

The first jaw 231 has two spaced-apart guide surfaces or pins 242 and 244 extending between the spaced-apart walls 234 at the proximal end of the first jaw 231. The second jaw 232 has a pin 246 at its distal end extending between the second jaw side walls 236 and has another pin 248 which is located between the first pin 246 and the elongate slots 238 and which extends between the second jaw side walls 236.

A V-shaped spring 250 is mounted so that interior angle at the apex of the V-shaped configuration receives the pin 240. The upper leg of the spring 250 is biased outwardly against the second jaw first pin 248, and the lower leg of the spring 250 is biased outwardly against the first jaw pin 242. This arrangement continuously biases the second jaw 232 toward the open position.

An operating cord 254 is provided for closing the second jaw 232 relative to the first jaw 231. The cord 254 has a closed loop 256 at its distal end, and the second jaw distal end pin 246 is engaged by the loop 256. The operating cord 254 extends proximally in the second jaw 232 toward the proximal end of the second jaw 232.

At the proximal end of the second jaw 232, the cord 254 is trained around the first jaw pin 242, then around the second jaw pin 248, and then around the first jaw pin 244. The cord 254 extends proximally from the first jaw pin 244 into the proximal portion of the instrument (not shown) where it can be tensioned by suitable means (such as manually or with an operating lever that may be similar to the lever 100 of the first embodiment of the jaw assembly described above with reference to FIG. 2).

When the cord 254 is tensioned, the second jaw 232 is pivoted downwardly to the closed position illustrated in FIG. 12. When the tension on the cord 254 is released, the spring 254 urges the second jaw 232 to the open position illustrated in FIG. 16.

Alternatively, the cord 254 may be provided as a continuous (endless) loop around the second jaw distal end pin 246, and the trailing portions of the loop can extend together back to the proximal end around the pins 242, 248 and 244 in the same manner as the single cord length described above. Both trailing portions would be tensioned together to operate the jaw assembly.

Another embodiment of the jaw assembly of the present invention is illustrated in FIGS. 13, 13A, and 14. The jaw assembly includes a first jaw 261 having a distal end and a proximal end, and the assembly incudes a second jaw 262 having a distal end and a proximal end. The proximal end of the first jaw 261 defines a pair of spaced-apart side walls 264 and 265.

The second jaw 262 has a pair of spaced-apart walls 266 and 267 projecting downwardly and received

between the first jaw side walls 264 and 265. A pivot shaft or pin 268 is mounted in the second jaw side walls 266 and 267. One end of the pin 268 is received in an elongate slot 271 defined in the first jaw side wall 264, and the other end of the pin 268 is received in an elongate slot 272 defined in the first jaw side wall 265 (FIG. 13A). A roller 274 is disposed on the pin 268.

Located distally of the elongate slots 271 and 272 in the first jaw 261 is a pin 278 which extends between, and which is mounted at each end to, the side walls 264 and 265. A roller 280 is disposed on the pin 278.

Located proximally of the elongate slots 271 and 272 in the first jaw 261 are vertically spaced-apart pins 284 and 286. Each pin 284 and 286 extends between, and is mounted in, the first jaw walls 264 and 265. Spaced above the pin 284 is a transverse guide member 288 which extends between the first jaw walls 264 and 265.

A first operating cord 290 defines a loop around the jaws 261 and 262. In particular, the cord 290 has a bottom portion 292 engaged with the bottom of the first jaw 261. To this end, the bottom of the first jaw 261, and a portion of each side of the jaw 261, define a groove or channel 294 for receiving the cord 290 in a recessed relationship.

The cord 290 extends upwardly from the cord bottom portion 292 along each side of the jaw assembly, over the top of the second jaw 262 and back down along opposite sides of the second jaw 262. Preferably, a receiving channel or groove 296 is defined in the top and sides of the second jaw 262 for receiving the lengths of the cord 290.

Two portions of the cord 290 each extend downwardly along each side of the second jaw 262 from the top of the jaw 262 to the roller 280 carried on the first jaw 261. The portions of the cord 290 then extend proximally from the roller 280 between the first jaw side walls 264 and 265. The cord lengths 290 are engaged with the roller 274 on the pin 268 and then extend between the pins 284 and 268 proximally of the elongate slots 271 and 272. The lengths of the cord 290 extend through a suitable slot 300 in the first jaw 261 and further into the instrument where they may be tensioned manually or by suitable means. For example, the proximally extended lengths of the cord 290 can be joined together to form a continuous loop and may be attached in the proximal portion of the instrument to an operating lever (e.g., similar to the lever 100 of the first embodiment of the jaw assembly described above with reference to FIG. 2).

A second operating cord 302 is attached to the proximal end of the second jaw 262. To this end, the second jaw walls 266 and 267 carry a pin 306. The secondary operating cord 302 has a loop at its distal end engaged with the pin 306.

The cord is received between the guide member 288 and pin 284 in the first jaw 261, and the cord 302 extends proximally through a slot 308 in the proximal end of the first jaw 161.

The proximal end of the cord 302 may be formed into a loop (not illustrated) in the proximal portion of the instrument for being pulled manually or by means of a suitable lever or other mechanism.

Although not illustrated, it may be desirable in some applications to provide a spring similar to the spring 250 described above with reference to the embodiment illustrated in FIGS. 11 and 12. Such a spring would bias the second jaw 262 upwardly to the open position.

In operation, the second operating cord 302 can be initially tensioned to pull the proximal end of the second jaw 262 upwardly and rearwardly relative to the pivot pin 268. The pivot pin 268 is maintained at the upper ends of the elongate slots 271 and 272 in the open position. The jaw 262 can be maintained in this open position by maintaining tension on the second operating cord 302 even if a biasing spring is not employed to assist in opening the second jaw 262.

When it is desired to close the second jaw 262, tension is initially still maintained on the second operating cord 302. The tension is ultimately released gradually, and in a timed manner, as tension is applied to the first operating cord 290. However, initially, sufficient tension is maintained on the second operating cord 302 to keep the pin 268 in the elevated position in the slots 271 and 272 so that the distal end of the second jaw 262 engages the tissue between the jaws before the proximal portion of the first jaw 262 engages the tissue. In this respect, when the second jaw 262 has moved to an intermediate closed position, the second jaw 262 would be angled somewhat downwardly similar to the orientation shown for the jaw 122 in the second embodiment illustrated in FIG. 9.

As the tissue is compressed between the jaws, the total reaction forces on the second jaw 262 increase and the closing force required at the distal end of the second jaw 262 must increase to effect further closure. The clamping angle changes as the second jaw 262 closes further. This change in geometry results in an increasing fraction of the increasing tension in the first operating cable 290 being transferred to the distal end of the second jaw 262. The distal end of the second jaw 262 provides a tissue compression force which prevents the tissue from slipping out of the jaws as the jaws close.

The tension in the second operating cable 302 is gradually released to permit the proximal end of the second operating jaw 262 to move downwardly (under the increasing force applied by the first operating cable 290). The pin 268 thus moves downwardly to the bottoms of the slots 271 and 272, and the jaws may then assume a substantially parallel orientation with the tissue clamped between the jaws.

FIGS. 15-18 illustrate another embodiment of jaw assembly of the present invention. The assembly includes a first jaw 801 having a distal end and a proximal end, and includes a second jaw 802 having a distal end and a proximal end. The proximal end of the first jaw 801 includes a pair of side walls 804 (FIG. 18). Each

wall 804 defines an elongate slot 806.

The first jaw 801 also includes a first guide pin 808 located distally of the slots 806 and extending between the walls 804. A pair of spaced-apart sleeves or rollers 810 are disposed on the pin 808 (FIGS. 15 and 18).

A second guide pin 814 is located proximally of the slots 806 in the first jaw 801. The second guide pin 814 extends between the first jaw walls 804. A roller or sleeve 816 is mounted on the pin 814.

Finally, an upper pin 818 is mounted between the first jaw walls 804 above the pin 814.

The second jaw 802 includes a pair of side walls 822. The walls 822 are spaced-apart by an amount that is less than the spacing between the first jaw walls 804. Mounted between the second jaw side walls 822 is a pivot pin 824. The distal ends of the pin 824 extend into the slots 806 in the side walls 804 of the first jaw 801. Two sleeves or rollers 826 are mounted on the pin between the second jaw walls 822. The rollers 826 are spaced apart at the center.

The second jaw 802 includes a third guide pin 830 located distally of the slots 806 and extending between the second jaw walls 822. Two sleeves or rollers 832 are disposed on the pin 830. The rollers 832 are spaced apart at the middle of the pin 830.

A V-shaped spring 840 is mounted between the first jaw 801 and second jaw 802. The spring 840 is mounted so that the interior angle at the apex of the V-shaped configuration of the spring receives the pivot shaft 824 between the spaced-apart rollers 826.

The upper leg of the spring 840 is biased outwardly against the second jaw guide pin 830 between the two spaced- apart rollers 832. The end of the other leg of the spring 840 is biased outwardly against the first jaw guide pin 808 between the two spaced-apart rollers 810. This arrangement tends to continuously bias the second jaw 802 toward the open position (FIGS. 15 and 18).

A first operating cord 850 has two portions or lengths extending into the proximal end of the first jaw 801, one length on each side of the spring 840. Each length has a first portion extending between the pin 814 and pivot shaft 824. Each first portion of the cord 850 engages the roller 816 on the pin 814 and the roller 826 on the pivot shaft 824.

Each portion of the cord 850 extends distally from the pivot shaft 824 and sequentially around the guide pin 808 on the first jaw 801 and then around the guide pin 830 on the second jaw 802. The cord engages the roller 810 on the pin 808 and engages the roller 832 on the pin 830.

The cord extends from the guide pin 830 on the second jaw 802 down to the bottom of the first jaw 801 on each side of the spring 840. To this end, the bottom of the jaw 801 define two spaced-apart bores 856 (FIG. 18) to accommodate passage of a portion of the cord 850. As shown in FIG. 18, the downwardly extending portions of the cord 850 define a common horizontal portion 858 below the first jaw 801. As viewed in FIG. 18, the portions of the cord 850 in the bottom of the first jaw 801 define a generally U-shaped configuration around a bottom portion of the first jaw 801.

The portions of the operating cord 850 extending proximally of the jaw assembly can be joined together to form a continuous loop and may be attached in the proximal portion of the instrument (not illustrated) to an operating lever (e.g., similar to the lever 100 of the first embodiment of the jaw assembly described above with reference to FIG. 2).

A second operating cord 860 is connected to the second jaw 802. Specifically, the proximal end of the second jaw 802 includes a pin 862 extending between the walls 822. The second operating cord 860 is looped around the pin 862 and extends to the proximal portion of the instrument (not illustrated). The proximally extending lengths of the second operating cord 860 may be joined together to form a continuous loop and may be attached in the proximal portion of the instrument to an operating lever (e.g., similar to the lever 100 of the first embodiment of the jaw assembly described above with reference to FIG.2).

The second jaw 802 can be maintained in the maximum open position as illustrated in FIG. 15 by maintaining tension on the second operating cord 860. This ensures that the pivot shaft 824 is at the top of the slots 806 in the first jaw 801 and that the second jaw 802 is pivoted in a clockwise direction as viewed in FIG. 15 to a fully opened position.

When it is desired to close the jaw assembly, tension is applied to the first operating cord 850. Initially, sufficient tension is also maintained on the second operating cord 860 to hold the pivot shaft 824 in the elevated position in the slots 806. In a nearly closed position, the distal end of the second jaw 802 will be angled downwardly near the first jaw 801 as shown in FIG. 16. The proximal end of the second jaw 802 remains elevated owing to the continued application of tension to the second operating cord 860.

Because the distal end of the second jaw 802 engages the tissue on the first jaw 801 prior to the proximal portion of the second jaw 802 engaging the tissue, the tissue is initially clamped near the distal end of the jaws and prevented from being forced outwardly along the jaws.

When the tissue has been sufficiently compressed by the downwardly angled, distal end of the second jaw 802, the tension in the second operating cord 860 is gradually released while the tension on the first operating cord 850 is maintained or increased. This procedure may be effected in response to tactile sensation or visual observation. This process may also be effected by suitable devices for automatically timing the release of tension in the second operating cord 860.

When sufficient tension has been released in the second operating cord 860, the proximal end of the second jaw is pulled downwardly owing to the tension in the first operating cord 850. The pivot shaft 824 moves to the bottom of the slots 806 in the first jaw 801. The sec-

ond jaw 802 can then assume a substantially parallel orientation relative to the first jaw 801.

In the above-described embodiments, the cords, or portions of the cords, are preferably made from materials which are non-toxic and which have good physical, chemical, radiological, and biological characteristics. Some of the materials that may be used are the cobalt sterilizable, non-toxic, liquid-crystal, polyester-polyarylate polymer materials sold in the United States of America under the tradenames VECTRAN and VECTRA by Hoechst Celanese which has an office in Bridgewater, New Jersey, U.S.A. These materials also appear to exhibit a strength, resistance to creep, and thermal expansion coefficient which are especially suitable for use in surgical instruments.

It will be readily apparent from the foregoing detailed description of the invention and from the illustrations thereof that numerous other variations and modifications may be effected without departing from the scope of the novel concepts or principles of this invention.

Claims

1. A jaw assembly for a surgical instrument, said assembly comprising:

   a first jaw (61,121,231,261,801) having a distal end and a proximal end;

   a movable second jaw (76,122,232,262,802) having a distal end and a proximal end, one of said jaws defining an elongate slot adjacent its proximal end, and the other of said jaws having a transversely extending shaft (86,130,240,268,824) adjacent its proximal end and received in said slot for mounting said jaws together to accommodate translation and pivoting movement of said second jaw toward and away from said first jaw;

   a spring (90,148,250,840) biasing said second jaw relative to said first jaw for urging said second jaw to pivot away from said first jaw;

   a first operating cord (96,151,254,290,850) engaged with said second jaw at a first location distally of said shaft for pulling said second jaw to pivot said second jaw distal end toward said first jaw, said first operating cord also being engaged with said second jaw at a second location proximally of said first location for urging said second jaw proximal end away from said first jaw only during an initial portion of the pivoting movement of said second jaw distal end toward said first jaw.

2. The jaw assembly in accordance with Claim 1, further including a second operating cord (160) engaged with said second jaw proximal end whereby pulling said second cord (160) urges said second jaw proximal end toward said first jaw with concomitant relative displacement between said shaft and said slot.

3. The jaw assembly in accordance with Claim 1, in which:

   said first cord (96,151,254,290,850) defines a generally U-shaped configuration around a portion said first jaw; and

   said first cord includes two trailing portions which each extend along opposite sides of said jaw assembly.

4. The jaw assembly in accordance with Claim 1, in which said first cord defines a closed loop.

5. The jaw assembly in accordance with Claim 1, in which said shaft (86,130,240,268,824) is carried on said second jaw and said slot (84,126,238,271,806) is defined in said first jaw.

6. The jaw assembly in accordance with Claim 1, in which said first location is defined by a first roller (132,832) mounted on said second jaw engaged with said cord and said second location is defined by a second roller (136,274) mounted on said second jaw engaged with said first cord.

7. The jaw assembly in accordance with Claim 1, further including a guide portion (140) on said first jaw for engaging the length of said first cord that extends between said second jaw first and second locations.

8. The jaw assembly in accordance with Claim 1, further comprising:

   a lever (74) mounted for pivoting movement about a lever pivot axis fixed relative to said first jaw, said lever defining first (111) and second (112) surfaces, the distance between said lever pivot axis and any part of said first surface (111) being less than the distance between said lever pivot axis and any part of said second surface (112);

   the first operating cord (96) being engaged with said second jaw (76) and engaged with said lever first and second surfaces (111,112) for pulling said second jaw (76) to pivot toward said first jaw (61).

9. The jaw assembly in accordance with Claim 8, in which:

said lever (74) has a generally oval transverse cross section; and

said first and second surfaces (111,112) merge to define a continuous oval surface.

10. The jaw assembly in accordance with Claim 8, further including a spring (90) biasing said second jaw (76) relative to said first jaw (61) to urge each said shaft (86) toward one end of each said slot (84).

11. The jaw assembly in accordance with Claim 8, in which said second jaw (76) is carried on said first jaw (61).

12. The jaw assembly in accordance with Claim 8, in which said assembly further includes a spring (90) for biasing said jaws apart to an open orientation.

13. The jaw assembly in accordance with Claim 8, in which said first cord (96) is engaged with said second jaw (76) between said second jaw pivot axis and said distal end of said second jaw (76).

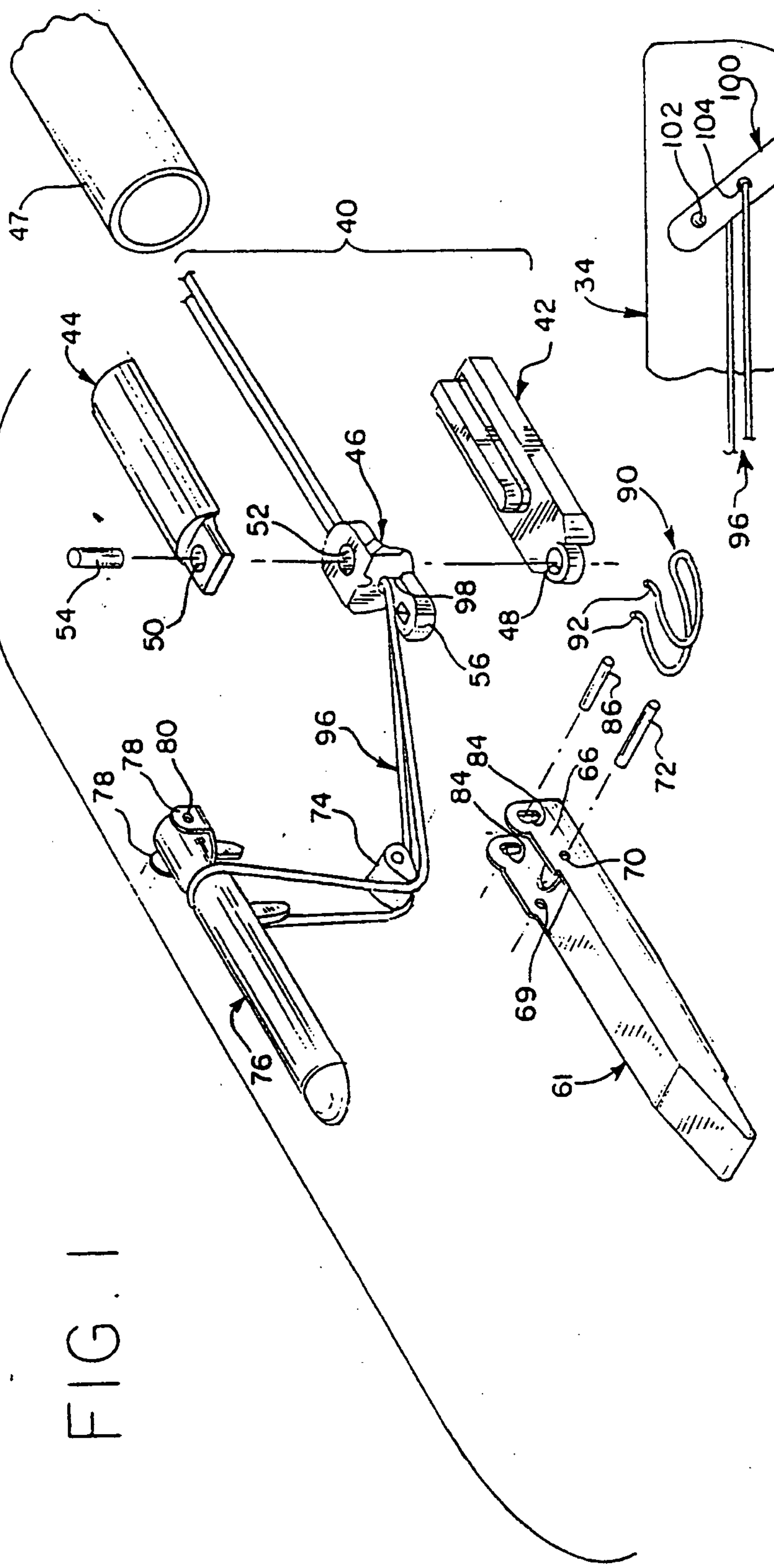
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FIG. 1

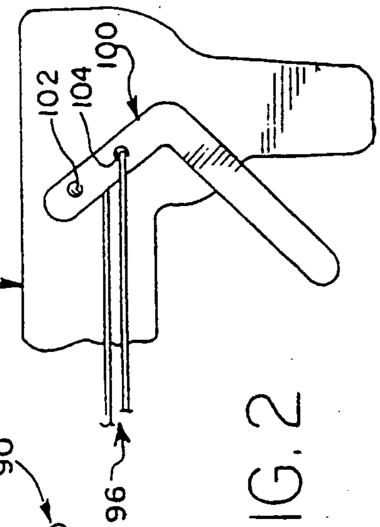
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FIG. 2

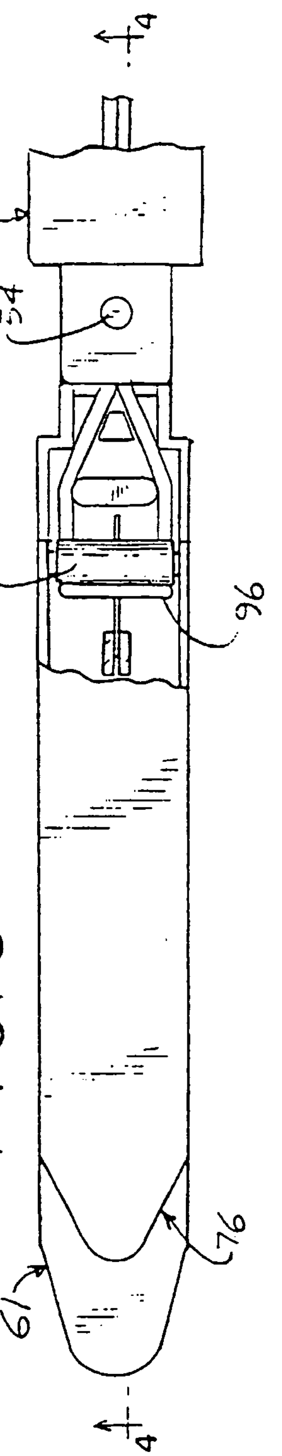


FIG. 3

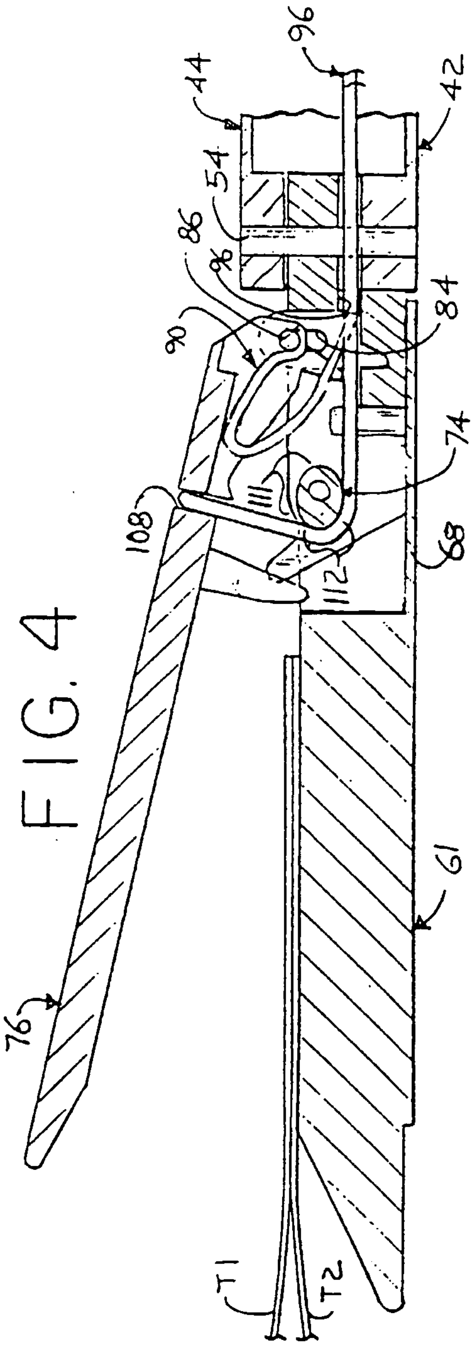


FIG. 4

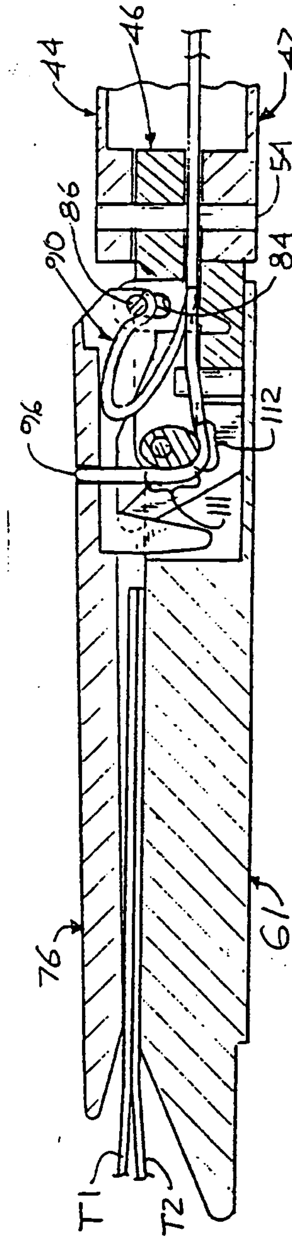


FIG. 5

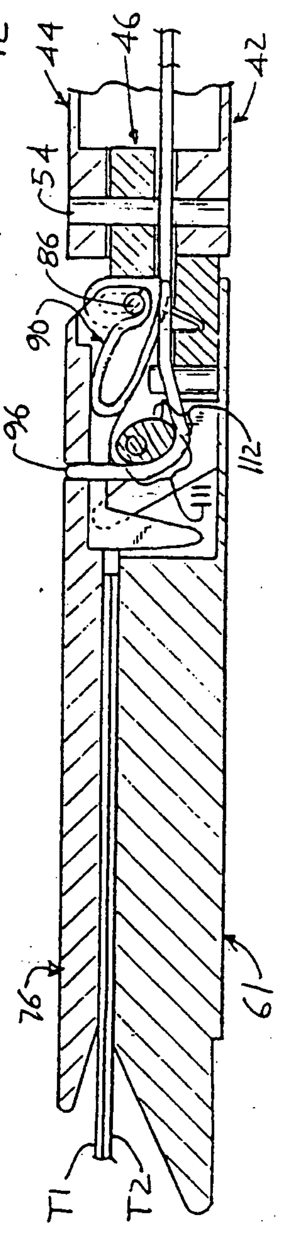


FIG. 6

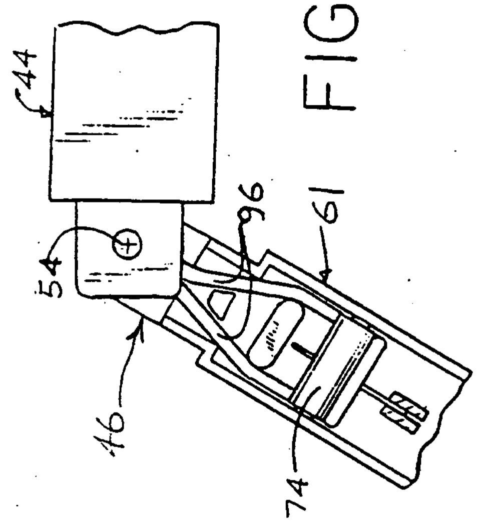


FIG. 7

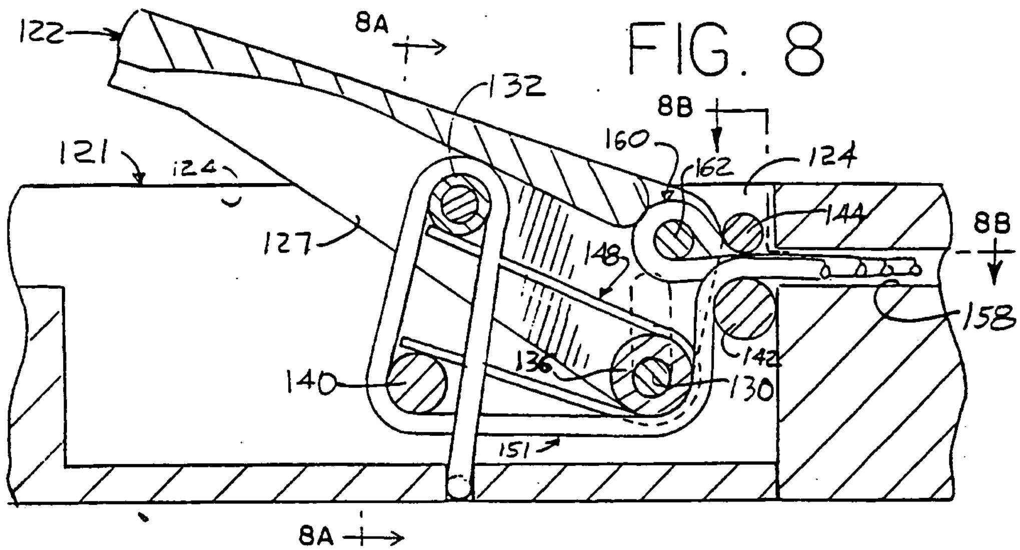


FIG. 8

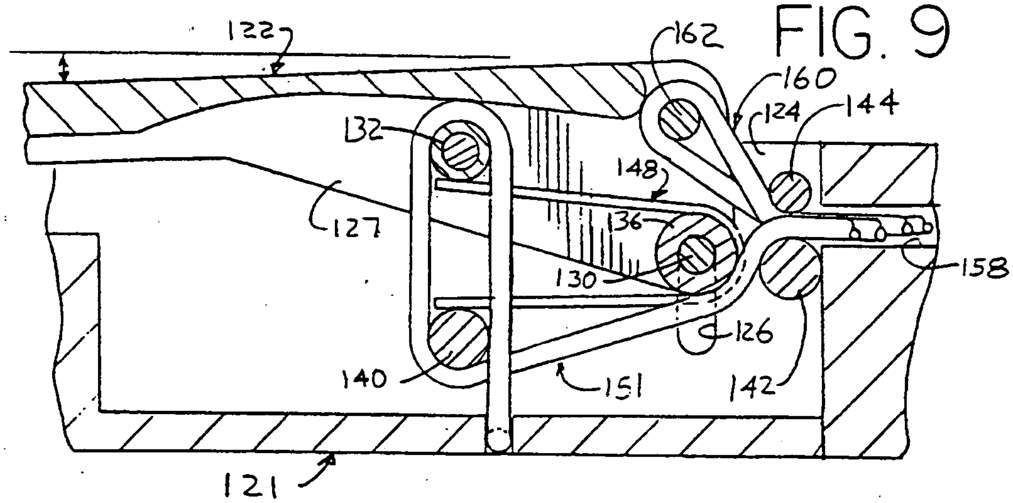


FIG. 9

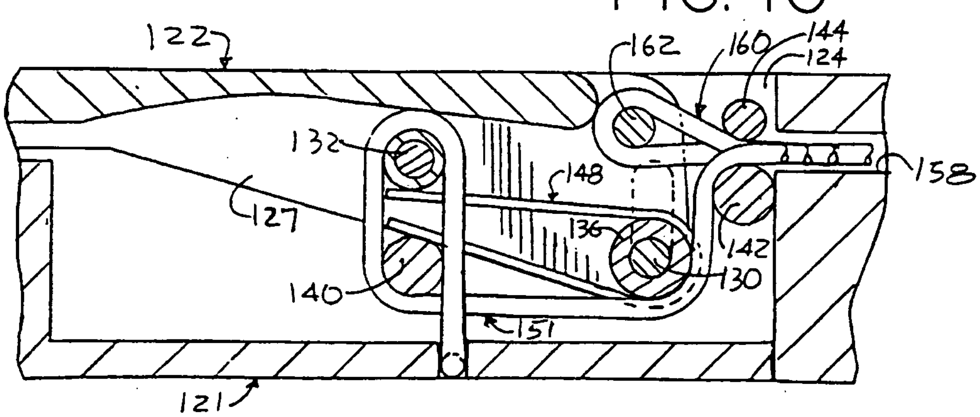
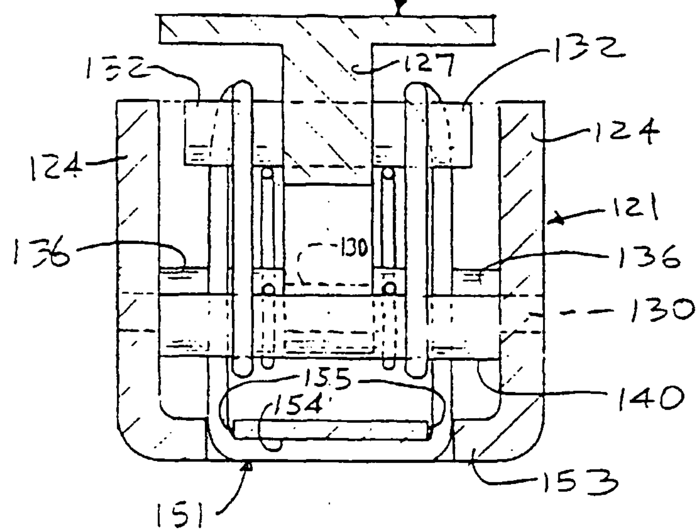


FIG. 10

FIG. 8A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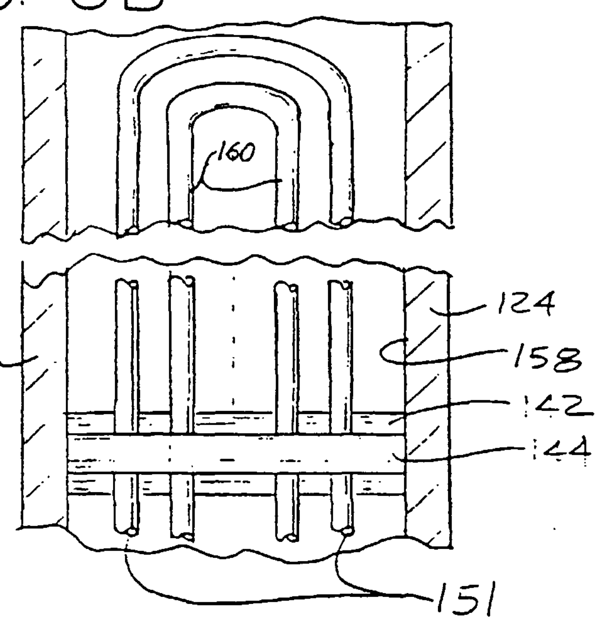
153
151

FIG. 8B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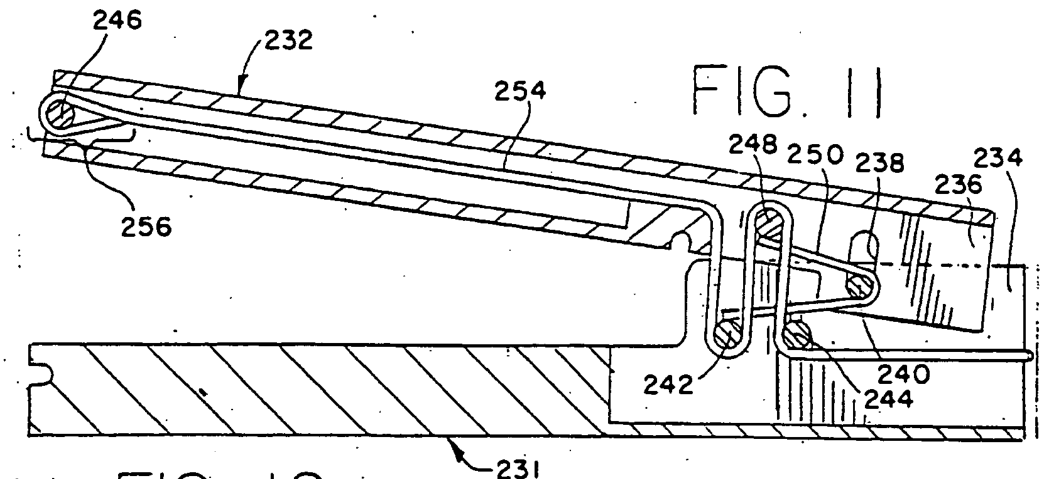
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231

FIG. 11

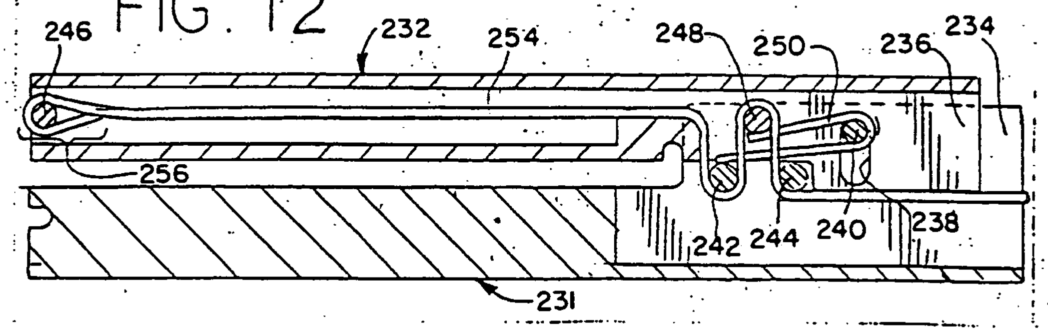
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FIG. 12

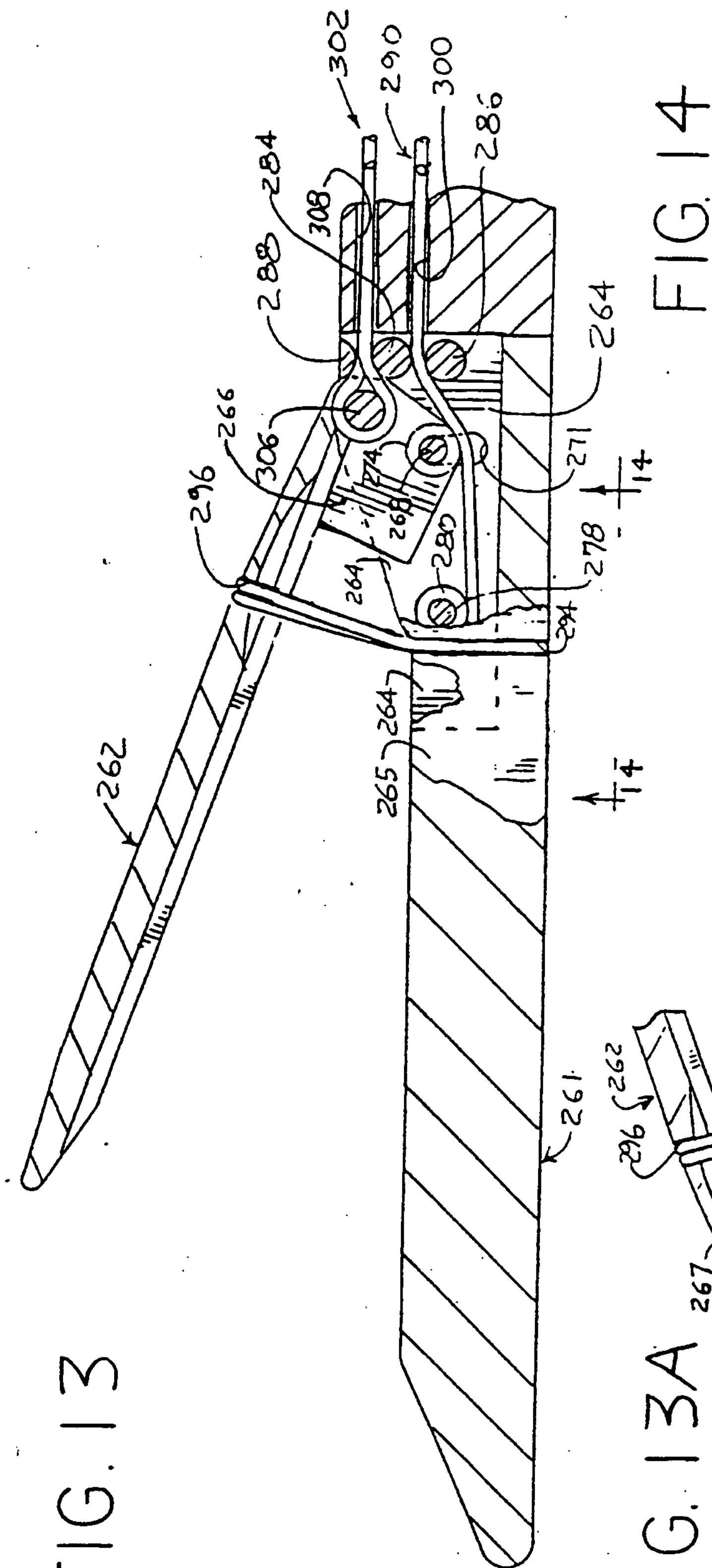


FIG. 13

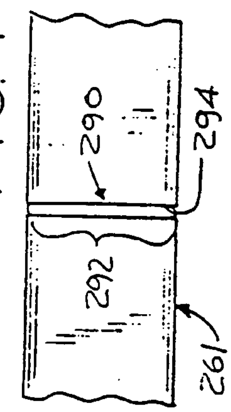


FIG. 14

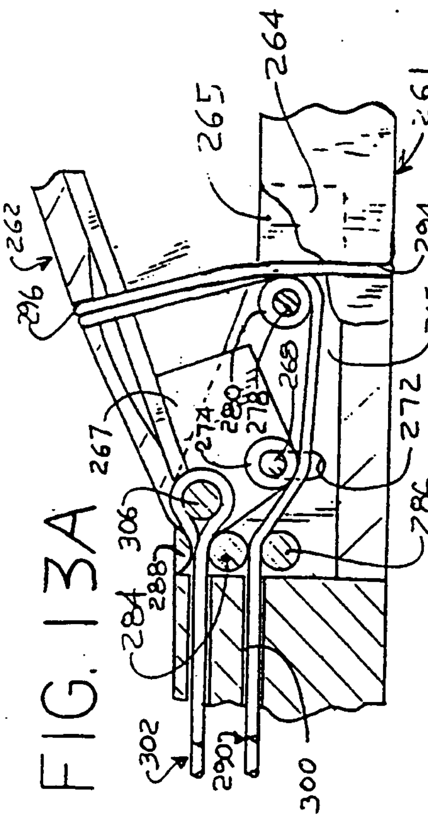


FIG. 13A

FIG. 18

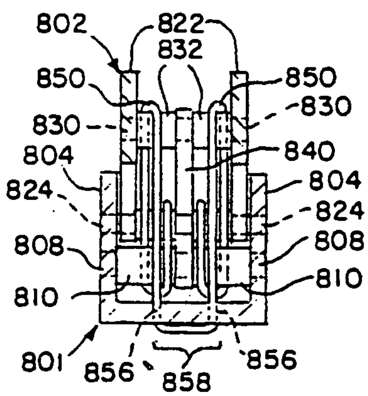


FIG. 15

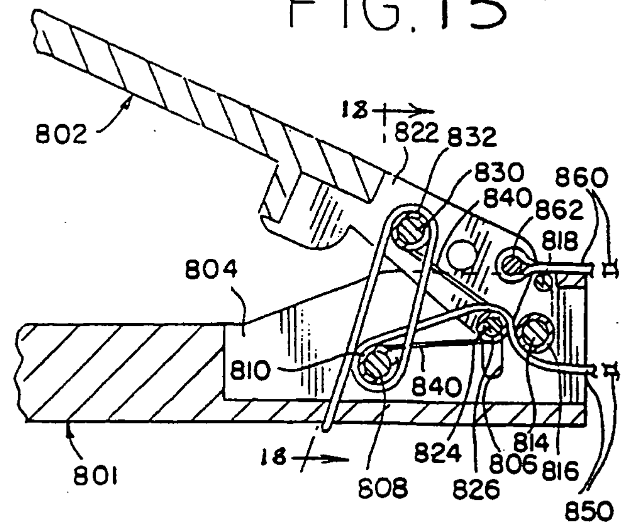


FIG. 16

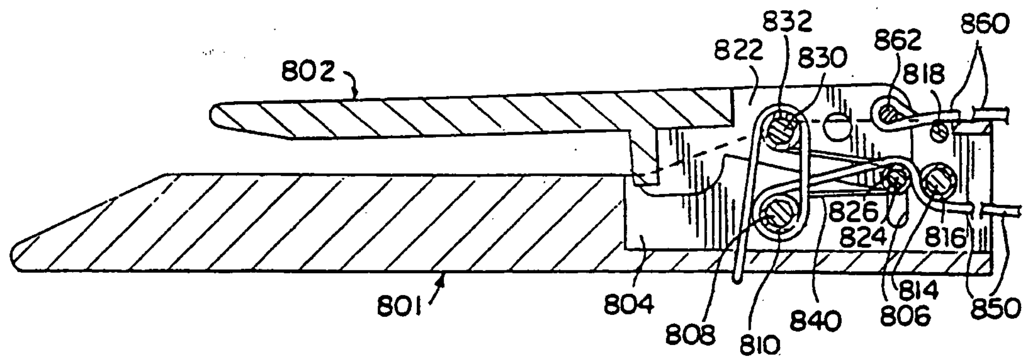
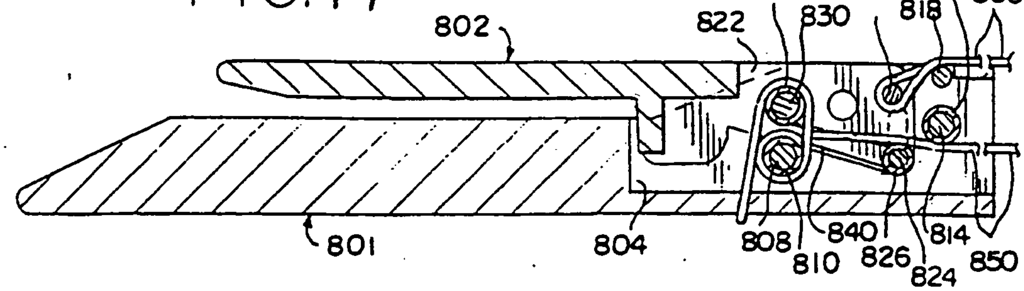


FIG. 17



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 1400

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	EP 0 484 677 A (UNITED STATES SURGICAL CORP) 13 May 1992 * column 13, line 10 - line 18 * ---	1	A61B17/28 A61B17/068
P,A	EP 0 603 472 A (UNITED STATES SURGICAL CORP) 29 June 1994 * figures 15,28,29 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			A61B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31 July 1997	Gérard, B

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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D : document cited in the application
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